



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification⁶:

A61K

A2

(11) International Publication Number:

WO 99/60988

(43) International Publication Date:

2 December 1999 (02.12.99)

(21) International Application Number: PCT/US99/11940

(22) International Filing Date: 28 May 1999 (28.05.99)

(30) Priority Data:

60/087,281

29 May 1998 (29.05.98)

US

(71) Applicant (for all designated States except US): UNIVERSITY OF FLORIDA [US/US]; 223 Grinter Hall, Gainesville, FL 32611 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): DUNN, Ben, M. [US/US]; 194 S.W. 131st Street, Newberry, FL 32669 (US). YAMAMOTO, Janet, K. [US/US]; 4309 S.W. 77th Street, Gainesville, FL 32608 (US). ARAI, Maki [JP/US]; Apartment #94, 2370 S.W. Archer Road, Gainesville, FL 32608 (US).

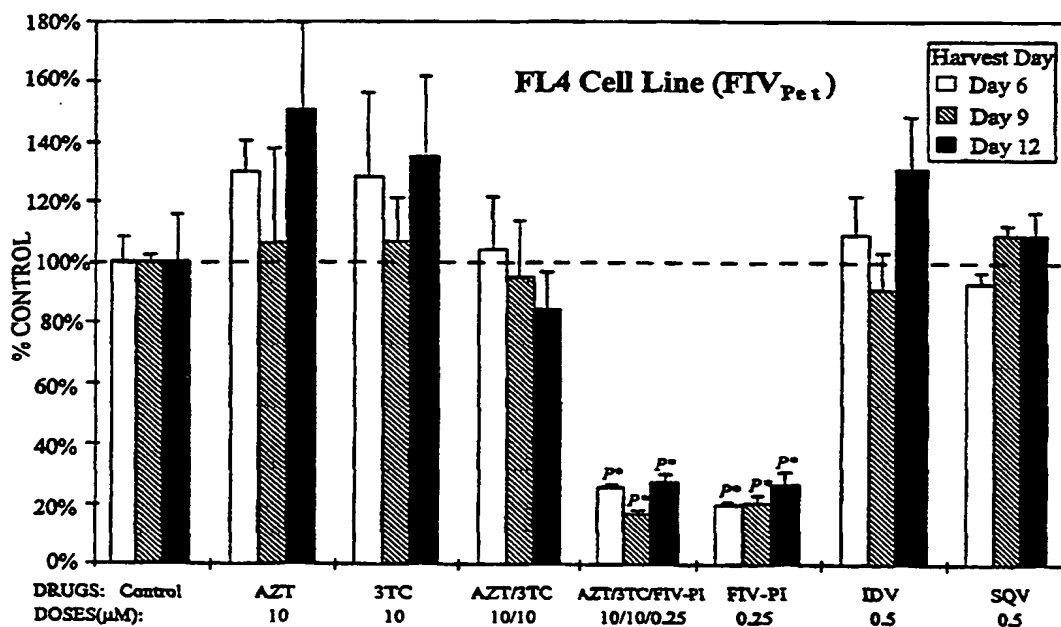
(74) Agents: PACE, Doran, R. et al.; Saliwanchik, Lloyd & Saliwanchik, A Professional Association, Suite A-1, 2421 N.W. 41st Street, Gainesville, FL 32606-6669 (US).

(81) Designated States: AE, AL, AU, BA, BB, BG, BR, CA, CN, CU, CZ, EE, GD, GE, HR, HU, ID, IL, IN, IS, JP, KP, KR, LC, LK, LR, LT, LV, MG, MK, MN, MX, NO, NZ, PL, RO, SG, SI, SK, SL, TR, TT, UA, US, UZ, VN, YU, ZA, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

Without international search report and to be republished upon receipt of that report.

(54) Title: COMBINATION THERAPY FOR TREATMENT OF FIV INFECTION



(57) Abstract

The subject invention pertains to methods for therapeutic and prophylactic treatment of cats against FIV infection. Methods of the present invention utilize a combination of antiretroviral compounds to treat or prevent FIV infection in a feline animal. In one embodiment, the method comprises administering an effective amount of AZT and another nucleoside analog, such as, for example, 3TC to the animal. In another embodiment, cats are given an effective dose(s) of AZT, 3TC and a retroviral protease inhibitor.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
2 December 1999 (02.12.1999)

PCT

(10) International Publication Number
WO 99/60988 A3

(51) International Patent Classification⁶: **A61K 31/70,**
A61P 37/00

Street, Gainesville, FL 32608 (US). **ARAI, Maki** [JP/US];
Apartment #94, 2370 S.W. Archer Road, Gainesville, FL
32608 (US).

(21) International Application Number: PCT/US99/11940

(22) International Filing Date: 28 May 1999 (28.05.1999)

(74) Agents: **PACE, Doran, R.** et al.; Saliwanchik, Lloyd &
Saliwanchik, A Professional Association, Suite A-1, 2421
N.W. 41st Street, Gainesville, FL 32606-6669 (US).

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/087,281 29 May 1998 (29.05.1998) US

(71) Applicant (for all designated States except US): **UNI-**
VERSITY OF FLORIDA [US/US]; 223 Grinter Hall,
Gainesville, FL 32611 (US).

(81) Designated States (national): AE, AL, AU, BA, BB, BG,
BR, CA, CN, CU, CZ, EE, GD, GE, HR, HU, ID, IL, IN,
IS, JP, KP, KR, LC, LK, LR, LT, LV, MG, MK, MN, MX,
NO, NZ, PL, RO, SG, SI, SK, SL, TR, TT, UA, US, UZ,
VN, YU, ZA.

(84) Designated States (regional): ARIPO patent (GH, GM,
KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM,
AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT,
BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC,
NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA,
GN, GW, ML, MR, NE, SN, TD, TG).

(72) Inventors; and

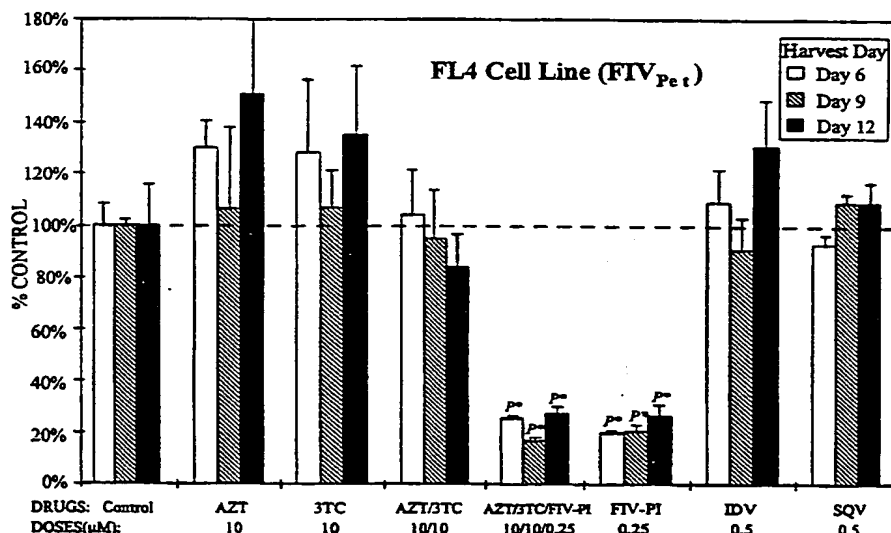
(75) Inventors/Applicants (for US only): **DUNN, Ben, M.**
[US/US]; 194 S.W. 131st Street, Newberry, FL 32669
(US). **YAMAMOTO, Janet, K.** [US/US]; 4309 S.W. 77th

Published:

— With international search report.

[Continued on next page]

(54) Title: COMBINATION THERAPY FOR TREATMENT OF FIV INFECTION



(57) Abstract: The subject invention pertains to methods for therapeutic and prophylactic treatment of cats against FIV infection. Methods of the present invention utilize a combination of antiretroviral compounds to treat or prevent FIV infection in a feline animal. In one embodiment, the method comprises administering an effective amount of AZT and another nucleoside analog, such as, for example, 3TC to the animal. In another embodiment, cats are given an effective dose(s) of AZT, 3TC and a retroviral protease inhibitor.

WO 99/60988 A3



(88) Date of publication of the international search report:
7 December 2000

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(15) Information about Correction:

Previous Correction:

see PCT Gazette No. 08/2000 of 24 February 2000, Section II

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/11940

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61K31/70 A61P37/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A61K A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	DE 197 03 131 A (BAYER AG) 30 July 1998 (1998-07-30) page 14, line 1-10; claim 5 ---	1-4
X	WO 97 03055 A (SLOAN KETTERING INST CANCER ;PROCHASKA HANS J (US)) 30 January 1997 (1997-01-30) page 21; claims 6,11,14,16; figure 1.6 ---	1-4
X	WO 96 22778 A (UNIV EMORY) 1 August 1996 (1996-08-01) page 8, line 1-5; claim 10 ---	1-4
X	WO 97 49411 A (GLAXO GROUP LTD ;BARRY DAVID WALTER (US); ST CLAIR MARTHA HEIDER () 31 December 1997 (1997-12-31) abstract; claim 13 page 6, line 1-15 ---	1-4
	--- -/--	



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *S* document member of the same patent family

Date of the actual completion of the international search

28 April 2000

Date of mailing of the international search report

08 AUG 2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Gonzalez Ramon, N

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/11940

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96 23509 A (MERCK & CO INC) 8 August 1996 (1996-08-08) abstract; claims 3,6,10,13 ---	1-4
X	WO 96 30025 A (WELLCOME FOUND ;BARRY DAVID WALTER (US); ST CLAIR MARTHA HEIDER (U) 3 October 1996 (1996-10-03) abstract; figure 1 page 5, paragraph 4 ---	1-4
E	WO 99 55372 A (GLAXO GROUP LTD ;CURRIE ROBIN (US); JAIN SUNIL (US); WOOD ALLEN WA) 4 November 1999 (1999-11-04) abstract; claim 1 ---	1-4
E	WO 99 66936 A (NOVIRIO PHARMACEUTICALS LIMITE;BRYANT MARTIN L ; MYERS MAUREEN W () 29 December 1999 (1999-12-29) abstract; claims 4,11,22,42,53 ---	1-4
Y	SMYTH N.R. ET AL: "Susceptibility in cell culture of feline immunodeficiency virus to eighteen antiviral agents." JOURNAL OF ANTIMICROBIAL CHEMOTHERAPY, (1994) 34/4 (589-594)., XP000904799 abstract; table 1 ---	1-4
Y	SMITH R.A. ET AL: "A novel Met-to-Thr mutation in the YMDD motif of reverse transcriptase from feline immunodeficiency virus confers resistance to oxathiolane nucleosides." JOURNAL OF VIROLOGY, (1997) 71/3 (2357-2362)., XP000891900 see discussion abstract ---	1-4
X	SMITH R A ET AL: "A novel point mutation at position 156 of reverse transcriptase from feline immunodeficiency virus confers resistance to the combination of (-)-beta-2',3'-dideoxy-3'-thiacytidine and 3'-azido-3'-deoxythymidine." JOURNAL OF VIROLOGY, (1998 MAR) 72 (3) 2335-40., XP000891901 see discussion abstract; figure 3 -----	1-4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 99/11940

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 1, 3, 4
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

B x II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see FURTHER INFORMATION PCT/ISA/210

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-4

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/SA/ 210

1. Claims: 1-4

Method of treating or preventing infection of feline immunodeficiency virus administering azidothymidine (AZT) and another nucleoside analog.

2. Claims: 5-12

Method of treating or preventing infection of feline immunodeficiency virus administering a combination of azidothymidine (AZT), another nucleoside analog and an inhibitor of a retroviral protease. Kits containing the same.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 1,3,4

Present claims 1,3,4 relate to a compound defined by reference to the following parameter: "nucleoside analog". The use of these parameters in the present context is considered to lead to a lack of clarity within the meaning of Article 6 PCT. It is impossible to compare the parameters the applicant has chosen to employ with what is set out in the prior art. The lack of clarity is such as to render a meaningful complete search impossible.

The claims cover all compounds having this characteristic or property, whereas the application provides support within the meaning of Article 6 PCT and/or disclosure within the meaning of Article 5 PCT for only a very limited number of such compounds. In the present case, the claims so lack support, and the application so lacks disclosure, that a meaningful search over the whole of the claimed scope is impossible. Independent of the above reasoning, the claims also lack clarity (Article 6 PCT). Again, this lack of clarity in the present case is such as to render a meaningful search over the whole of the claimed scope impossible. Consequently, the search for the first invention has been carried out for those parts of the claims which appear to be clear, supported and disclosed, namely those parts relating to the compounds specifically mentioned in the examples and in claim 2 with due regard to the general idea underlying the present application.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 99/11940

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19703131 A	30-07-1998	AU 6094098 A CN 1251525 T WO 9832442 A EP 0977570 A NO 993670 A PL 334770 A ZA 9800679 A	18-08-1998 26-04-2000 30-07-1998 09-02-2000 10-09-1999 13-03-2000 05-08-1998
WO 9703055 A	30-01-1997	AU 6676796 A	10-02-1997
WO 9622778 A	01-08-1996	US 5703058 A AU 717580 B AU 4705696 A CA 2211612 A EP 0805683 A JP 10512887 T US 5905070 A	30-12-1997 30-03-2000 14-08-1996 01-08-1996 12-11-1997 08-12-1998 18-05-1999
WO 9749411 A	31-12-1997	AU 3262797 A BR 9709939 A CA 2258956 A CN 1228026 A CZ 9804294 A EP 0938321 A NO 986034 A PL 330747 A ZA 9705564 A	14-01-1998 10-08-1999 31-12-1997 08-09-1999 16-06-1999 01-09-1999 23-02-1999 24-05-1999 23-12-1998
WO 9623509 A	08-08-1996	AU 711176 B AU 4774896 A BR 9607714 A CA 2211973 A CZ 9702444 A EP 0806957 A FI 973184 A HR 960045 A HU 9800810 A JP 10513186 T NO 973533 A NZ 302153 A PL 321660 A SK 103797 A ZA 9600722 A	07-10-1999 21-08-1996 13-01-1998 08-08-1996 14-01-1998 19-11-1997 30-09-1997 31-10-1997 28-07-1998 15-12-1998 01-10-1997 23-12-1998 22-12-1997 04-02-1998 26-08-1996
WO 9630025 A	03-10-1996	AP 652 A AU 715213 B AU 5497296 A BR 9607851 A CA 2216634 A CN 1185110 A CZ 9703090 A EP 0817637 A HU 9801571 A JP 10511682 T NO 974510 A PL 322532 A SK 129597 A JP 2954357 B	19-06-1998 20-01-2000 16-10-1996 21-07-1998 03-10-1996 17-06-1998 13-05-1998 14-01-1998 28-01-1999 10-11-1998 29-09-1997 02-02-1998 08-07-1998 27-09-1999

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 99/11940

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9955372 A	04-11-1999	AU 4135599 A	16-11-1999
WO 9966936 A	29-12-1999	AU 4716299 A	10-01-2000



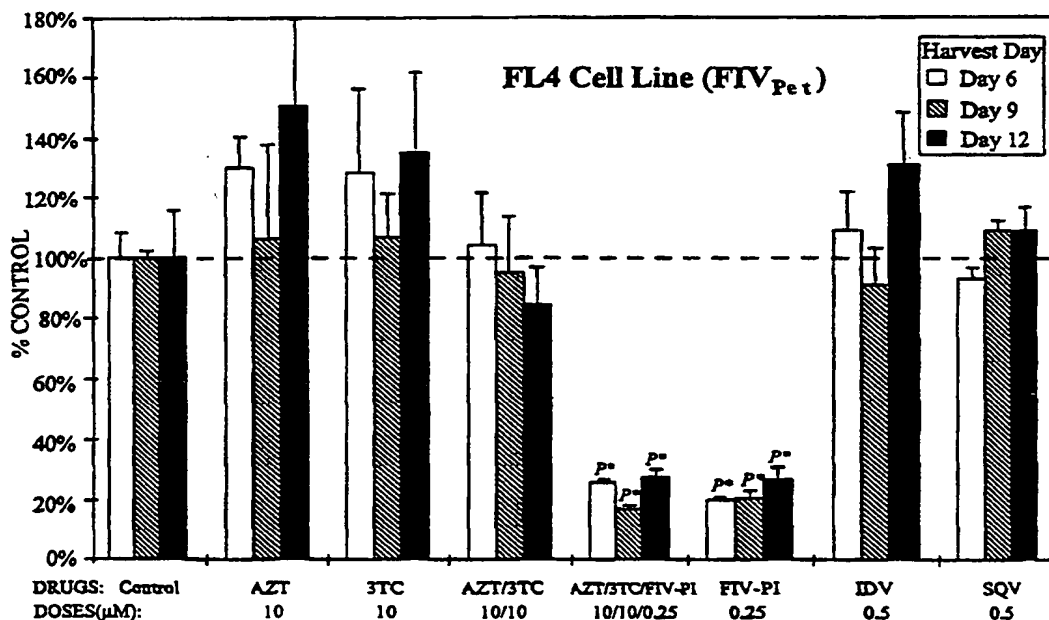
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : A61K		(11) International Publication Number: WO 99/60988
A2		(43) International Publication Date: 2 December 1999 (02.12.99)
(21) International Application Number: PCT/US99/11940		(81) Designated States: AE, AL, AU, BA, BB, BG, BR, CA, CN, CU, CZ, EE, GD, GE, HR, HU, ID, IL, IN, IS, JP, KP, KR, LC, LK, LR, LT, LV, MG, MK, MN, MX, NO, NZ, PL, RO, SG, SI, SK, SL, TR, TT, UA, US, UZ, VN, YU, ZA, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
(22) International Filing Date: 28 May 1999 (28.05.99)		
(30) Priority Data: 60/087,281 29 May 1998 (29.05.98) US		
(71) Applicant (for all designated States except US): UNIVERSITY OF FLORIDA [US/US]; 223 Grinter Hall, Gainesville, FL 32611 (US).		
(72) Inventors; and (75) Inventors/Applicants (for US only): DUNN, Ben, M. [US/US]; 194 S.W. 131st Street, Newberry, FL 32669 (US); YAMAMOTO, Janet, K. [US/US]; 4309 S.W. 77th Street, Gainesville, FL 32608 (US); ARAI, Maki [JP/US]; Apartment #94, 2370 S.W. Archer Road, Gainesville, FL 32608 (US).		
(74) Agents: PACE, Doran, R. et al.; Saliwanchik, Lloyd & Saliwanchik, A Professional Association, Suite A-1, 2421 N.W. 41st Street, Gainesville, FL 32606-6669 (US).		

Published

Without international search report and to be republished upon receipt of that report.

(54) Title: COMBINATION THERAPY FOR TREATMENT OF FIV INFECTION



(57) Abstract

The subject invention pertains to methods for therapeutic and prophylactic treatment of cats against FIV infection. Methods of the present invention utilize a combination of antiretroviral compounds to treat or prevent FIV infection in a feline animal. In one embodiment, the method comprises administering an effective amount of AZT and another nucleoside analog, such as, for example, 3TC to the animal. In another embodiment, cats are given an effective dose(s) of AZT, 3TC and a retroviral protease inhibitor.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Larvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

DESCRIPTIONCOMBINATION THERAPY FOR TREATMENT
OF FIV INFECTION

5

The subject invention was made with government support under a research project supported by NIH Grant AI30904. The government has certain rights in this invention.

10

Background of the Invention

Feline immunodeficiency virus (FIV) is a lentivirus which causes immunodeficiency syndrome in domestic cats (Pedersen *et al.*, 1987; Siebelink *et al.*, 1990). FIV closely resembles human immunodeficiency virus (HIV) in genomic, biochemical, and morphologic characteristics as well as clinical and hematological manifestations (Johnson *et al.*, 1994; Pedersen *et al.*, 1987; Yamamoto, Sparger *et al.*, 15 1988). As a result, FIV infection of domestic cats is considered to be an excellent small animal model for testing prophylactic and therapeutic strategies against AIDS viruses (Gardner, 1991; Johnson *et al.*, 1994). A number of antiretroviral drugs for HIV, including the prototype nucleoside analogue azidothymidine (AZT), has been tested 20 using the FIV model (Hart *et al.*, 1995; Hartmaun *et al.*, 1992; Hayees *et al.*, 1993; Hayees *et al.*, 1995; Meers *et al.*, 1993; North *et al.*, 1989; Smith *et al.*, 1994).

The therapeutic use of AZT has been unremarkable in cats and was unable to delay the spread of FIV infection *in vivo* (Hart *et al.*, 1995; Hartmaun *et al.*, 1992). Prophylactic AZT treatment of experimental cats caused either a delay or decrease in 25 both infected blood lymphocyte numbers and plasma virus load (Hayees *et al.*, 1993; Hayees *et al.*, 1995; Meers *et al.*, 1993; Smith *et al.*, 1994). In addition, a delay in FIV antibody production was observed in some animals (Smith *et al.*, 1994). However, prophylactic therapy with AZT did not protect cats from FIV infection (Meers *et al.*, 1993; Hayees *et al.*, 1993; Hayees *et al.*, 1995; Smith *et al.*, 1994). As reported for HIV 30 therapy, withdrawal of the drug resulted in a resurgence of the virus in these cats. When compared to the untreated group, significantly higher CD4 and CD8 cell counts were observed shortly after the withdrawal of the drug (Hayees *et al.*, 1993; Hayees *et al.*,

1995). However, CD4/CD8 ratios were not significantly different from the untreated cats. In contrast, FIV-infected cats therapeutically treated with AZT had no change in FIV antigen or anti-FIV antibody titers but had transient improvement in CD4/CD8 ratios and clinical signs (Hart *et al.*, 1995; Hartmaun *et al.*, 1992). These findings suggest that monotherapy with AZT has limited benefit as a therapy for FIV infection. Similar observations have been made with AZT monotherapy of HIV-infected individuals (Harrigan, 1995; Staszewski, 1995).

In recent trials, combination therapies with AZT and other antiretroviral drugs, such as phosphonomethoxyethyl adenine and dideoxycytidine 5'-triphosphate, had minimal to no effect in preventing or controlling FIV infection in cats (Hartmaun *et al.*, 1992; Magnani *et al.*, 1994; Philpott *et al.*, 1992). The *in vivo* use of viral protease inhibitors or new nucleoside analogue combinations, such as, for example, lamivudine (3TC) and AZT has yet to be reported in FIV-infected cats. Commercially available HIV protease inhibitors (*e.g.*, Sequinavir (SQV), Indinavir (IDV), Ritonavir, Nelfinavir) do not inhibit FIV replication in PBMC *in vitro*. Unlike other nucleoside analogues, 3TC rapidly induces mutations which can phenotypically reverse the mutations caused by AZT, enabling the antiviral activity of AZT to persist in the host (Boucher *et al.*, 1993; Larder, 1995; Tisdale *et al.*, 1993). This unique feature of 3TC makes it a prime candidate for use in combination with AZT. In HIV-positive individuals, the combination AZT/3TC therapy had synergistic or additive effects at decreasing plasma virus load and increasing CD4 cell counts and function (Katlama *et al.*, 1994; Lange, 1995; Paul *et al.*, 1995; Staszewski, 1995). The addition of an HIV protease inhibitor to this combination further decreased the viral load and improved the CD4 cell count (Deeks *et al.*, 1997; Torres *et al.*, 1997).

Brief Summary of the Invention

The subject invention concerns methods for therapeutic and prophylactic treatment of feline animals against infection by FIV. Methods of the present invention utilize a combination of antiretroviral compounds. In one embodiment, an effective amount of a composition comprising AZT and another nucleoside such as 3TC. In another embodiment, cats are given an effective dose(s) of a composition comprising

AZT, a nucleoside analog such as 3TC and a retroviral protease inhibitor. In an exemplified embodiment, the protease inhibitor is HBY-793 (Hoescht-Bayer).

Brief Description of the Drawings

5 **Figure 1** shows anti-FIV activities of AZT, 3TC, FIV-PI, and HIV-PI (IDV and SQV) in chronically FIV-infected cell lines. The antiviral activity of the drugs at noncytotoxic doses were evaluated in feline T-cell lines chronically infected with either FIV_{Pet} (subtype A strain) (panel A), or FIV_{Bang} (subtype B strain) (panel B). The RT data are presented as % control, whereby % control represents RT mean of triplicate treated
10 cultures divided by RT mean of triplicate untreated cultures and multiplied by 100. The RT data on harvest days at 6, 9, and 12 are shown. The results from treated culture sets which are statistically different from the values of the untreated controls are indicated by either $p < 0.05$ (P) or $p < 0.005$ (P^*) based on Student T test.

Figure 2 shows anti-FIV activities of AZT, 3TC, FIV-PI, and FIV-PI in primary
15 PBMC infected with FIV_{Bang}. Six separate experiments with varying concentrations and combinations were performed and the results from two representative experiments are shown. Nucleoside analogue and PI doses were $0.1 \mu\text{M}$ in Experiment 1 (panel A) and $0.05 \mu\text{M}$ and $0.01 \mu\text{M}$, respectively, in Experiment 2 (panel B). The RT data are presented as % control and the results from treated culture sets which are statistically
20 different from the values of the untreated controls are indicated by either $p < 0.05$ (P) or $p < 0.005$ (P^*) based on Student T test. The Harvest Day 16 result for AZT/3TC culture set was statistically different ($p < 0.03$) from the results of AZT culture set and 3TC culture set from the same time point, as indicated by (Y) above AZT/3TC bar (panel A). The Day 9 and 12 harvest results for AZT/3TC/FIV-PI culture set were statistically
25 different ($p < 0.05$) from the results of AZT/3TC culture set and FIV-PI culture set from the same time points, as indicated by (Z) above AZT/3TC/FIV-PI bars (panel B).

Figure 3 shows anti-FIV activities of AZT, 3TC, FIV-PI, and HIV-PI in primary
PBMC infected with FIV_{UK-8} (subtype A strain). Four separate experiments with varying concentrations and combinations were performed and the results from two representative
30 experiments are shown. Nucleoside analogue and P1 doses were $0.1 \mu\text{M}$ and 0.01 - $0.5 \mu\text{M}$, respectively, in Experiment 1 (panel A) and $0.05 \mu\text{M}$ and 0.01 - $0.5 \mu\text{M}$ respectively, in Experiment 2 (panel B). The RT data are presented as % control and the results from

treated culture sets which are statistically different from the values of the untreated controls are indicated by either $p < 0.05$ (P) or $p < 0.005$ (P^*). Statistical differences existed between the results of AZT/3TC culture set and 3TC culture set at Harvest Days 17 ($p < 0.02$) and 20 ($p < 0.001$) in panel A and Harvest Days 9 ($p < 0.02$), 12 ($p < 0.04$), and 15 ($p < 0.02$) in panel B, as indicated by (X) above the AZT/3TC bars. In addition, statistical difference existed between the results of AZT/3TC culture set and AZT culture set at Harvest Day 20 ($p < 0.001$) in panel A and Harvest Day 15 ($p < 0.01$) in panel B, as indicated by (Z) above the AZT/3TC bars.

Figure 4 shows the chemical structure of the protease inhibitor designated herein as HBV-793.

Detailed Disclosure of the Invention

The subject invention concerns methods for therapeutic and prophylactic treatment of cats against infection by FIV. Methods of the present invention utilize a combination of antiretroviral compounds. In one embodiment, cats can be administered an effective amount of a composition comprising AZT and another nucleoside analog. Preferably, the nucleoside analog is 3TC.

In another embodiment of the methods of the present invention, cats are given an effective dose(s) of a composition comprising AZT, another nucleoside analog and a retroviral protease inhibitor. Preferably, the nucleoside analog is 3TC. In an exemplified embodiment, the protease inhibitor is HBV-793. The structure of HBV-793 is shown in Figure 4. Other retroviral protease inhibitors that can inhibit FIV proteases are contemplated within the scope of this invention.

FIV-infected cats treated according to the methods of the present invention can also be given bone marrow transplantation after total body irradiation in conjunction with the antiretroviral drug combination therapy. The bone marrow transplanted can be either allogeneic or autologous.

The antiretroviral compositions of the subject invention can be administered using standard procedures known in the art. For example, the compositions can be administered as oral or nasal formulations. The compositions can also be administered by parenteral injection, *i.e.*, intravenous, intramuscular, or subcutaneous injection. The

amounts and dosage regimens for administration can readily be determined by the ordinarily skilled clinician.

Cats that are not infected with FIV can be treated according to the methods of the present invention to provide effective prophylactic treatment against FIV infection. FIV-infected cats can be treated according to the subject methods to provide effective therapy for controlling, inhibiting or eliminating FIV infection in that cat.

Results from studies described herein show that the addition of a nucleoside analog like 3TC to prophylactic AZT therapy will completely protect cats against FIV infection. This observation is supported by the *in vitro* findings demonstrating that an AZT/3TC combination was more effective at inhibiting FIV replication in PBMC cultures than single-drug treatments using AZT or 3TC alone. The AZT/3TC combination is effective when used prophylactically or immediately upon FIV exposure. In addition, the combination of antiretroviral drugs AZT/3TC/FIV-PI can be used as an anti-FIV therapy to treat chronically infected animals.

The present invention also concerns kits comprising in one or more containers AZT, another nucleoside analog and an inhibitor of a retroviral protease. Preferably, the nucleoside analog is 3TC. In a preferred embodiment, the retroviral protease inhibitor is HBY-793.

The following abbreviations of FIV strains are used herein:

<u>Strain (subtype)</u>	<u>Abbreviation</u>
Petaluma (A)	FIV _{Pet}
Dixon (A)	FIV _{Dix}
UK8 (A)	FIV _{UK-8}
Bangston (B)	FIV _{Bang}
Aomori-1 (B)	FIV _{Aom1}
Aomori-2 (B)	FIV _{Aom2}
Shizuoka (D)	FIV _{Shi}

All references cited herein are incorporated by reference.

Following are examples which illustrate procedures for practicing the invention. These examples should not be construed as limiting. All percentages are by weight and all solvent mixture proportions are by volume unless otherwise noted.

5 Example 1 – *In vitro* Efficacy of AZT, 3TC, and PI

In the first set of *in vitro* studies, feline T-cell lines chronically infected with FIV_{Pet} (FL-4 cells) or FIV_{Bang} (FIV_{Bang}/FeT-J cells) at 2×10^5 cells/ml were treated for 3 weeks with a single drug or various combinations of AZT, 3TC, an FIV protease inhibitor (FIV-PI; Hoescht-Bayer HBY-793), and HIV protease inhibitors (HIV-PI) (Fig. 1A and 1B). Saquinavir (SQV) and Indinavir (IDV) were used as the HIV-PIs. Culture supernatants were harvested and the cells were resuspended in fresh culture media containing appropriate drug(s) at 34 day intervals. Viral replication was determined by measuring the levels of reverse transcriptase (RT) activity in the culture supernatants (Rey *et al.*, 1984). Drug toxicity in these cultures were monitored by viability and absolute cell count analyses using trypan blue exclusion method (Mishell *et al.*, 1980). Single and combination drug doses which were determined to be nontoxic to the test cells were used in these studies.

Both single and combination treatments with AZT and 3TC had minimal to no effect at inhibiting RT activity in FIV_{Bang}/FeT-J cells (20-50% inhibition) and FL-4 cells (0-10% inhibition). In contrast, FIV-PI treatment inhibited FIV replication by 70-80% in both cell lines (Fig. 1A and 1B). However, the addition of an AZT/3TC combination did not enhance this inhibition. Furthermore, neither SQV nor IDV alone had significant anti-FIV effect (Fig. 1A and 1B). The differences in anti-FIV activities of these nucleoside analogues and FIV-PI may be due to the differences in the mechanism(s) of their antiviral activities. AZT and 3TC exert their antiretroviral activity by preventing the reverse transcription of viral RNA into viral DNA, whereas FIV-PI prevents the production of a whole virion by inhibiting the FIV protease from cleaving viral gag-pro--pol precursor into their individual components. Therefore, cell lines which have proviral integration will not be affected by nucleoside analogues. Based on semi-quantitative PCR analysis, FIV_{Bang}/FeT-J cells and FL-4 cells used in current study had proviral integration of 50-80% and >95%, respectively (data not shown). The minor anti-FIV activity of AZT and 3TC observed in FIV_{Bang}/FeT-J cells may be due to the antiviral

effect of the nucleoside analogues on the 20-50% of the cells which were still free of FIV proviral integration. As expected, potent anti-FIV activity was observed with FIV-PI in both proviral integrated cell lines.

As a means to simulate *in vivo* conditions, primary peripheral blood mononuclear cells (PBMC) from specific pathogen free (SPF) cats were next used as the indicator cells. Primary PBMC isolated by ficoll hypaque method were stimulated with concanavalin A for 3 days and cultured for an additional 2 weeks before their use in drug studies (Staszewski, 1995). Antiretroviral drug(s) were added to the PBMC cultures (1×10^6 cells/ml) immediately before FIV_{Bang} (subtype B) or FIV_{UK-8} (subtype A) inoculation of 100 50% tissue culture infectious dose (TCID₅₀). Both single and combination treatments with AZT and 3TC inhibited the FIV replication in PBMC at doses which were not toxic to the cells (Fig. 2A and 3A). Synergism in antiviral activities of AZT/3TC combination was observed against both FIV_{Bang} and FIV_{UK-8} strains (Fig. 2A, 3A, and 3B). The addition of the FIV-PI to the AZT/3TC combination further enhanced the activities of these drugs against FIV_{Bang} (Fig. 2B). Such enhancement was not observed against FIV_{UK-8} at the doses used (Fig. 3A and 3B). Thus, the anti-FIV activities of AZT, 3TC, and FIV-PI are not restricted to specific FIV strain or subtype, although some strains appear to be more sensitive to one drug over another. Similar to previous studies with chronically infected cells, single-drug treatments with FIV-PI but not HIV-PIs (SQV and IDV) inhibited FIV replication in PBMC cultures (Fig. 2A, 3A, and 3B). Furthermore, addition of SQV or IDV to the AZT/3TC combination did not enhance the antiviral activity of the AZT/3TC combination. The lack of anti-FIV activity of SQV and IDV may be explained by the fact that HIV-PIs do not efficiently bind to FIV protease, whereas the FIV-PI used in this study efficiently binds to HIV protease as well as FIV protease (Dunn *et al.*, 1994; Wlodawer *et al.*, 1995). These results show that dual and triple combinations of AZT, 3TC, and FIV-PI may have therapeutic benefit against FIV infection in domestic cats.

Example 2 – Prophylactic Efficacy of AZT/3TC in Cats

Based on the findings from *in vitro* studies, the prophylactic use of AZT/3TC combination was next tested in experimental cats. Four of the eight SPF cats (16-20 weeks of age) received oral administration of AZT and 3TC (75 mg/kg each) twice a day

(BID), while remaining cats received placebo. This treatment dose was based on the *in vivo* research, in which six SPF cats (2 cats per treatment group) treated (BID) with either AZT or 3TC at 100 mg/kg or AZT/3TC combination at 50 mg/kg each had no hematological or clinical abnormalities after two weeks of treatment. In this study, all cats except for one treated cat (#RUI) were inoculated with 100 50% cat infectious dose (C1D₅₀) of FIV_{UK-8} at 3 days after the first drug or placebo treatment. FIV_{UK-8} was used in this study because this strain gave more consistent CD4/CD8 ratio inversion in a larger number of infected cats than did infection with FIV_{Bang} or FIV_{Pet}. All cats received either the drug or placebo treatments throughout the first 11 weeks after FIV inoculation, unless stated otherwise. The cats were monitored daily for clinical signs and twice a month for hematological changes, FIV load in PBMC and plasma, anti-FIV antibody titers, and CD4/CD8 ratio and absolute counts (Diehi *et al.*, 1995; Green *et al.*, 1993; Okada *et al.*, 1994; Tellier *et al.*, 1997; Yamamoto *et al.*, 1991).

At 4 weeks of treatment, severe anemia was observed in all challenged and unchallenged cats treated with AZT/3TC; therefore, the doses of each drug were lowered to 34 mg/kg each at 4 weeks of treatment and subsequently to 5-10 mg/kg each at 5 weeks of treatment. AZT/3TC treatment was terminated in one cat (#3GB) at 6 weeks of treatment, and the treatment was resumed 6 days later at 5 mg/kg each. Based on virus isolation and PCR analyses, one cat (#101) from the placebo group was positive for FIV by 3 weeks post infection (pi) and had anti-FIV antibodies by 5 weeks pi (Table 1). However, plasma viral RNA levels of this cat were not detected throughout the study; even though the virus load in the PBMC was similar to the levels detected in the remaining placebo cats. These placebo cats (#NK4, #NK6, #IH5) were positive for FIV titers in the plasma and PBMC and for anti-FIV antibodies by 7 weeks pi. Furthermore, all placebo cats, except for cat #101, had transient or persistent CD4/CD8 inversion starting 11 weeks pi. In contrast, all AZT/3TC-treated cats were negative for FIV and had no CD4/CD8 inversion throughout the study. Both drug and placebo treatments were terminated at 11 weeks pi and all cats were monitored for additional 6-13 weeks. In the previous reports, an increase in FIV load of the PBMC was observed after the withdrawal of AZT treatment in FIV-infected cats (Hayees, *et al.*, 1993; Hayees *et al.*, 1995; Meers *et al.*, 1993). Thus, if low levels of FIV infection undetectable by current assays existed in AZT/3TC-treated cats, then such infection should rebound when the drugs are

removed. In this study, all AZT/3TC-treated cats remained negative for FIV in PBMC and anti-FIV antibodies throughout the 6-13 weeks after the withdrawal of the drug treatment. Virus isolation and PCR of bone marrow and lymph node cells performed at the termination of the study further confirmed the FIV-free status of these cats. Thus, complete protection of cats against experimental FIV infection was achieved with prophylactic AZT/3TC therapy.

Example 3 – Therapeutic Efficacy of AZT/3TC in Chronically FIV-Infected Cats

Based on the *in vivo* toxicity observed in the prophylactic study, three cats (#101, #NK6, #144) chronically infected with FIV_{UK-8} for 16 weeks were treated at 20 mg/kg of each drug (BID), while an additional three infected cats (#1H5, #NK4, #158) received placebo. These cats were treated with either drug combination or placebo for 8 weeks and monitored an additional 4 weeks for changes in FIV load and CD4/CD8 values. All parameters monitored were identical to those of the prophylactic study. All treated cats developed either mild or severe anemia by 3.5 weeks of treatment. As a result, both drug doses were lowered to 10 mg/kg. Nevertheless, the anemia in one cat (#144) became so severe by 6 weeks of treatment that the drug treatment was terminated for 1 week and resumed thereafter at a low dose of 5 mg/kg of each drug (BID). Unlike the prophylactic study, no significant differences in either FIV load or CD4/CD8 ratios and absolute counts were observed between the treated and placebo cats (Table 2). This study in combination with the previous studies suggest that doses even as low as 20 mg/kg of each drugs when used over moderate period of time (3.5 weeks or longer) will cause anemia in cats. However, short-term treatment (2 weeks) with high dose combination (75 mg/kg each) is well tolerated by cats.

Example 4

Allogeneic bone marrow transplantation (BMT) in combination with total body irradiation (TBI) and anti-FIV drug therapy was evaluated as an immune reconstitution therapy for FIV-infected cats. The rationale for this therapy is as follows: (1) TBI will decrease FIV load by destroying recipient's hematopoietic cells, including FIV-infected immunocytes. (2) Anti-FIV drug therapy can block the infection of engrafted donor cells in the BMT recipients. (3) BMT with donor BM cells from uninfected cats will

reconstitute normal hematopoietic system. The TBI/BMT combination alone was unable to decrease the virus load due to rapid infection of engrafted donor cells. A majority of FIV-infected recipients of allogeneic BMT succumbed to graft-versus-host disease, accelerated FIV-related diseases, or their combination. As a result, studies were performed to identify antiretroviral drugs that can be combined with TBI/BMT. Prophylactic therapy with AZT/3TC combination protected 100% of the cats from FIV_{UK-8} challenge infection. Moreover, the only FIV-infected cat to survive allogeneic BMT also received concurrent AZT/3TC therapy. This cat had complete hematopoietic engraftment including normal CD8 counts. However, its CD4 counts were only slightly higher than the levels observed before BMT. Furthermore, only slight decrease in plasma virus load was observed during high-dose AZT/3TC therapy. Nonetheless, its anti-FIV antibody titers were 100-fold lower than those before BMT. This cat was still healthy at one year post-BMT and is still responsive to AZT/3TC therapy.

Example 5

Recent findings with anti-HIV triple-drug combination have revealed that triple-drug cocktails are unable to immune reconstitute the patient with normal numbers and repertoire of T cell populations or to completely decrease/remove the virus load in the lymphoid tissues within feasible duration of time. As such, autologous bone marrow transplantation (BMT) was tested in combination with antiretroviral drugs as an immune reconstitution therapy for FIV-infected cats. Based on preliminary results, no significant decrease in FIV load or improvement in CD4/CD8 ratios or counts were detected in infected cats that received autologous BMT one (1) day after total body irradiation (TBI). These cats survived the autologous BMT and are currently alive over two years after BMT. This is in contrast to the results from allogeneic BMT of FIV-infected cats, whereby all cats except the one on AZT/3TC therapy succumbed to GVHD, accelerated FIV-disease, or their combination. The extension of the time of BMT after TBI will decrease the infected cell reservoir load and, consequently, fewer infected cells will be available to infect engrafted cells. Addition of antiretroviral drug therapy will prevent any remaining infected cell reservoir from contaminating the engrafted cells.

Example 6 – Pharmaceutical Compositions

Antiviral compounds of the invention can be formulated according to known methods for preparing pharmaceutically useful compositions. *Remington's Pharmaceutical Science* by E.W. Martin describes formulations which can be used in connection with the subject invention. In general, the compositions of the subject invention will be formulated such that an effective amount of the antiviral compounds are is combined with a suitable carrier in order to facilitate effective administration of the composition. It should, of course, be understood that the compositions and methods of this invention may be used in combination with other therapies.

The compositions used in these therapies may also be in a variety of forms. These include, for example, solid, semi-solid, and liquid dosage forms, such as tablets, pills, powders, liquid solutions or suspensions, liposomes, suppositories, injectable, and infusible solutions. The preferred form depends on the intended mode of administration and therapeutic application. The compositions also preferably include conventional pharmaceutically acceptable carriers and adjuvants which are known to those of skill in the art. Preferably, the compositions of the invention are in the form of a unit dose.

Once improvement in condition has occurred, a maintenance dose is administered if necessary. Subsequently, the dosage or the frequency of administration, or both, may be reduced, as a function of the symptoms, to a level at which the improved condition is retained.

It should be understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and the scope of the appended claims.

TABLE 1. AZT/3TC prophylaxis of cats starting 3 days before FIV inoculation

AZT/3TC treatment ^a	FIV	FIV levels ^b						FIV antibodies ^b				CD4/CD8 ratio ^{bc}					
		(kg/mg)	Pre	4 wk	9 wk	11 wk	14 wk	Pre	4 wk	9 wk	11 wk	14 wk	Pre	7 wk	11 wk	14 wk	
Cat #	-0.4→4→5→6-7 wk	inocul.															
DH5	75→34→10	+	-/-	-/-	-/-	-/-	-/-	-/-	-	-	-	-	-	3.30	2.86	2.62	2.38
3GB	75→34→10→0.5	+	-/-	-/-	-/-	-/-	-/-	-/-	-	-	-	-	-	1.56	1.37	1.37	1.47
RU2	75→34→10	+	-/-	-/-	-/-	-/-	-/-	-/-	-	-	-	-	-	1.77	1.21	1.18	1.18
RU1	75→34→10	-	-/-	-/-	-/-	-/-	-/-	-/-	-	-	-	-	-	2.37	1.62	1.62	1.47
NK4	-	+	-/-	+/+/+	+/+/+	+/+/+	+/+/+	+/+/+	-	-	+	+	+	1.82	1.55	0.96	0.91
NK6	-	+	-/-	-/+/-	+/+/+	+/+/+	+/+/+	+/+/+	-	-	+	+	+	1.61	0.92	0.46	0.45
IO1	-	+	-/-	+/+/-	+/+/-	+/+/-	+/+/-	+/+/-	-	-	+	+	+	3.40	1.73	1.24	1.23
III5	-	+	-/-	-/+/-	+/+/+	+/+/+	+/+/+	+/+/+	-	-	+	+	+	4.40	1.34	0.60	0.61

12

a The AZT/3TC treatment was started 3 days before FIV inoculation (-0.4 post-infection) at a dose of 75 mg/kg each and decreased to 34 mg/kg at 4 wk post-infection (pi) and then to 10 mg/kg at 5 wk pi. In one cat (#3GB), the AZT/3TC treatment was withdrawn at 6 wk pi and resumed at a low dose of 5 mg/kg at 7 wk pi. The changes in doses if each drug, including the amount (mg/kg) and time (wk pi), are shown.

b Samples before drug or placebo treatment (Pre) and those at various weeks post-infection (wk) were tested for FIV levels, FIV antibodies, and CD4/CD8 ratios. FIV levels were determined by virus isolation (VI), PCR for FIV provirus in PBMC, and RT-PCR for plasma viral RNA (vRNA). FIV antibodies were determined by immunoblot analysis. In general, RT-PCR for plasma viral RNA was less sensitive than PCR of FIV provirus in PBMC after amplification of infected cells by coculturing.

c Inverted CD4/CD8 ratios are bolded.

TABLE 2. AZT/3TC therapy of FIV-infected cats

Cat No.	AZT/3TC treatment ^a (kg/mg)	FIV load ^b (No. of infected cells in PBMC)												FIV antibodies ^b				CD4/CD8 ratio ^b			
		0 wk	3.5 wk	8 wk	12 wk	0 wk	3.5 wk	8 wk	12 wk	0 wk	3.5 wk	8 wk	12 wk	0 wk	3.5 wk	8 wk	12 wk				
		0 wk→3.5 wk→6-7 wk																			
I01	20 → 10	++	+	+	++	+	+	++	++	+	+	++	++	1.45	1.58	1.71	1.71				
NK6	20 → 10	++	++	+	+	+	+	+	++	++	++	++	++	0.45	1.00	0.64	0.70				
144	20 → 10 → 0.5	+++	+++	+++	++	+++	+++	++	++	++	++	++	++	0.67	0.74	0.45	0.52				
III5	-	++	++	+	ND	+	+	+	++	++	++	++	++	0.61	0.63	0.73	0.87				
NK4	-	++	+	+	+	+	+	+	+	+	++	++	++	0.91	1.25	1.54	1.54				
158	-	+++	+++	+++	++	+++	+++	++	++	+	++	++	++	1.08	1.01	1.33	1.06				

^a The doses of each drug were decreased from 20 mg/kg to 10 mg/kg at 3 weeks treatment. Treatment was withdrawn in one cat (#144) at 6 weeks of treatment and resumed one week later at 5 mg/kg. The changes in doses of each drug, including amount (mg/kg) and time (wk after initial treatment), are shown.

^b Samples before drug or placebo treatments (0 wk) and those at various weeks after initial treatment (wk) were tested for FIV levels, FIV antibodies, and CD4/CD8 ratios. FIV loads were determined by the number of PBMC (50 to 5x10⁶ PBMC cocultured with 5x10⁶ feeder PBMC) needed for positive virus isolation. Virus isolation results are presented as 50 (++++), 5x10² (+++), 5x10³ (++) and 5x10⁴ (+) PBMC from treated and untreated cats needed to isolate FIV from a culture containing 5x10⁶ uninfected feeder PBMC. FIV antibody titer is defined as the minimal dilution (in Log₁₀) at which antibodies to FIV major core protein (p26) could be detected. Serial log dilutions of serum (10⁻⁴ to 10⁻⁷ dilution) were incubated with immunoblot strip for 2 hrs and processed using the immunoblot method. End point titrations of FIV antibodies are presented as 10⁻⁵ (+) and 10⁻⁶ (++).

References

- 5 Boucher, C.A.B., N. Cammack, P. Schipper, P. Rouse, M.A. Wainberg, and J.M. Cameron (1993) "High-level resistance to (-) enantiomeric 2'-deoxy-3'-thiacytidine in vitro is due to one amino acid substitution in the catalytic site in human immunodeficiency virus type 1 reverse transcriptase" *Antimicrob. Agents Chemother.* 37:2231-2234.
- 10 Deeks, S.G., M. Smith, M. Holodniy, J.O. Kahn (1997) "HIV-1 protease inhibitors" *J. Am. Med. Assoc.* 277:145-153.
- 15 Diehi, L.J., C.K. Mathiason-Dubard, L.L. O'Neil, and E.A. Hoover (1995) "Longitudinal assessment of feline immunodeficiency virus kinetics in plasma by use of a quantitative competitive reverse transcriptase PCR" *J. Virol.* 69:2328-2332.
- Dunn, B.M., A. Gustchina, A. Wlodawer, and J. Kay (1994) "Subsite preference of retroviral proteinases" *Meth. Enzymol.* 241:254-278.
- 20 Gardner, M.B. (1991) "Mini-review. Simian and feline immunodeficiency viruses: animal lentivirus models for evaluation of AIDS vaccines and antiviral agents" *Antiviral Res.* 15:267-286.
- 25 Green, W.K., J. Meers, G. del Fierro, P.R. Carnegie, and W.F. Robinson (1993) "Extensive sequence variation of feline immunodeficiency virus env genes in isolates from naturally infected cats" *Arch. Virol.* 133:51-62.
- Harrigan, R. (1995) "Measuring viral load in the clinical setting" *J. Acquir. Immune Defic. Syndr. Hum Retrovirol.* 10(Suppl. 1):534-540.
- 30 Hart, S., and I. Nolte (1995) "Long-term treatment of diseased, FIV-seropositive field cats with azidothymidine (AZT)" *J. Vet. Med. A.* 42:397-409.
- 35 Hartmaun, K., A. Donath, B. Beer, H.F. Egberink, M.C. Horzinek, H. Lutz, G. Hoffmann-Fezer, I. Thum, and S. Thefeld (1992) "Use of two virustatica (AZT, PMEA) in the treatment of FIV and of FeLV seropositive cats with clinical symptoms" *Vet. Immunol. Immunopathol.* 35:167-175.
- 40 Hayees, K.A., L.J. Lafrado, J.G. Erickson, J.M. Marr, and L.E. Mathes (1993) "Prophylactic ZDV therapy prevents early viremia and lymphocyte decline but not primary infection in feline immunodeficiency virus-inoculated cats" *J. Acquir. Immune Defic. Syndr.* 6:127-134.
- 45 Hayees, K.A., J.G. Wilkison, R. Frick, S. Francke, and L.E. Mathes (1995) "Early suppression of viremia by ZDV dose not alter the spread of feline immunodeficiency virus infection in cats" *J. Acquir. Immune Defic. Syndr. Hum. Retrovirol.* 9:114-122.

- Johnson, M.C., B.A. Torres, H. Koyama, and J.K. Yamamoto (1994) "FIV as a model for AIDS vaccination" *AIDS Res. Hum. Retroviruses* 10:225-228.
- 5 Katlama, C., and the European Zidovudine Working Group (1994) "Combination 3TC (lamivudine) / ZVD (zidovudine) versus ZVD monotherapy in ZVD naive HTV-1 positive patients with CD4 of 100-400 cells/mm³, abstr" *AIDS* 8(Suppl. 4):56.
- Lange, J.M.A. (1995) "Triple combinations: present and future" *J. Acquir. Immune Defic. Syndr. Hum. Retrovirol.* 10(Suppl. 1):577-582.
- 10 Larder, B.A. (1995) "Viral resistance and the selection of antiretroviral combinations" *J. Acquir. Immune Defic. Syndr. Hum. Retrovirol.* 10(Suppl.1):528-533.
- 15 Magnani, M., L. Rossi, A. Fraternale, L. Silvotti, F. Quintavalla, G. Piedimonte, D. Matteucci, F. Baldinotti, and M. Bendinelli (1994) "Feline immunodeficiency virus infection of macrophages: In vitro and in vivo inhibition by dideoxycytidine-5'-triphosphate-loaded erythrocytes" *AIDS Res. Hum. Retroviruses* 10:1179-1186.
- 20 Meers, J., G.M. del Fierro, IL B. Cope, H. S. Park, W. K Greene, and W. F. Robinson (1993) "Feline immunodeficiency virus infection: plasma, but not peripheral blood mononuclear cell virus titer is influenced by zidovudine and cyclosporine" *Arch. Virol.* 132:67-81.
- 25 Mishell, B.B., S.M. Shilgi, C. Henry, E.L. Chan, I. North, R. Gallily, M. Slomich, K. Miller, I. Marbrook, D. Parks, and A.H. Good (1980) "Preparation of mouse cell suspensions" p.3-27. In B.B. Mishell and S.M. Shiigi (ed.), *Selected methods in cellular immunology*. W.H. Freeman and Co. San Francisco, CA.
- 30 Newell, M.L., and D.M. Gibb (1995) "A risk-benefit assessment of zidovudine in the prevention of perinatal HIV transmission" *Drug-Saf.* 12:274-282.
- 35 North, T.W., G.L.T. North, and N.C. Pedersen (1989) "Feline immunodeficiency virus, a model for reverse transcriptase-targeted chemotherapy for acquired immunodeficiency syndrome" *Antimicrob. Agents Chemother.* 33:915-919.
- Okada, S., R. Pu, E. Young, W. Stoffs, and J.K. Yamamoto (1994) "Superinfection of cats with FIV subtypes A and B" *AIDS Res. Hum. Retroviruses* 10:1739-1746.
- 40 Paul, D.B., M.C. Kuhns, A. Al. McNamara, J.C. Jr. Pottage, and G.T. Spear (1995) "Short-term stability of HIV provirus levels in the peripheral blood of HIV-infected individuals" *J. Med. Virol.* 47:292-297.
- 45 Pedersen, N.C., E.W. Ho, M.L. Brown, and J.K. Yamamoto (1987) "Isolation of a lymphotropic virus from domestic cats with an immunodeficiency-like syndrome" *Science* 235:790-793.

- Philpott, M.S., J.P. Ebner, and E.A. Hoover (1992) "Evaluation of 9-(2-phosphonylmethoxyethyl) adenine therapy for feline immunodeficiency virus using a quantitative polymerase chain reaction" *Vet. ImmunoL Immunopathol.* 35:155-166.
- Rey, M.A., B. Spire, D. Dormont, F. Barre-Sinoussi, L. Montagnier, and J.C. Chermann (1984) "Characterization of the RNA dependant DNA polymerase of new human T-lymphotropic retrovirus (lymphadenopathy associated virus)" *Biochem. Biophys. Res. Commun.* 21:1247-1253.
- Siebelink, K.H.J., I-H. Chu, G.F. Rimmelzwaan, K. Weijer, R.V. Herwijnen, P. Kenell, H.F. Egberink, M.L. Bosch, and A.E.M.E. Osterhaus (1990) "Feline immunodeficiency virus (FIV) infection in the cats as a model for HIV infection in man: FIV-induced impairment of immune function" *AIDS Res. Hum. Retroviruses* 6:1373-1378.
- Smith, N.R., M. Bennett, R.M. Gaskell, C.M. McCracken, C.A. Hart, and J.L. Howe (1994) "Effect of 3'azido-2'3'-deoxythymidine (AZT) on experimental feline immunodeficiency virus infection in domestic cats" *Res. Vet. Sci.* 57:220-224.
- Staszewski, S. (1995) "Zidovudine and lamivudine: results of phase III studies" *J. Acquir. Immune Defic. Syndr. Hum Retrovirol.* 10(Suppl. 1):557.
- Tellier, M.C., J.M. Soos, R. Pu, and J.K. Yamamoto (1997) "Development of FIV-specific cytolytic T-lymphocyte responses in cats upon immunization with FIV vaccines" *Vet. Microbiol.* 57:1-11.
- Tisdale, M., S.D. Kemp, N.R. Parry, and B.A. Larder (1993) "Rapid in vitro selection of human immunodeficiency virus type 1 resistant to 3'-thiacytidine inhibitors due to a mutation in the YMDD region of reverse transcriptase" *Proc Natl. Acad. Sci. USA* 90:5663-5666.
- Torres, R.A. and M.R. Barr (1997) "Combination antiretroviral therapy for HIV infection" *Infect. Med.* 14:142-160.
- Wlodawer, A., A. Gustchina, L. Reshetnikova, J. Lubkowski, A. Zdanov, K.Y. Hui, E.L. Angleton, W.G. Farmerie, M.M. Goodenow, D. Bhatt, L. Zhang, and B.M. Dunn. (1995) "Structure of an inhibitor complex of the protease from feline immunodeficiency virus" *Nature Struct. Biol.* 2:480-488.
- Yamamoto, J.K., T. Okuda, C.D. Ackley, H. Loule, H. Zochlinski, E. Pembroke, and M.B. Gardner (1991) "Experimental vaccine protection against feline immunodeficiency virus" *AIDS Res. Hum. Retroviruses* 7:911-922.
- Yamamoto, J.K., N.C. Pedersen, E.W. Ho, T. Okuda, and G.H. Theilen (1988) "Feline immunodeficiency syndrome - A comparison between feline T-lymphotropic lentivirus and feline leukemia virus" *Leukemia* 2(Suppl. 12):2045-2155.

Yamamoto J.K., E. Sparger, E.W. Ho, P.R. Andersen, T.P. O'Connor, C.P. Mandell, L. Lowenstine, R. Munn, and N.C. Pedersen (1988) "Pathogenesis of experimentally induced feline immunodeficiency virus infection in cats" *Am. J. Vet. Res.* 49:1246-1258.

Claims

- 1 1. A method for treating or preventing infection of feline immunodeficiency virus
2 (FIV) in a feline animal, said method comprising administering to said feline animal an
3 effective amount of azidothymidine (AZT) and another nucleoside analog.
- 1 2. The method according to claim 1, wherein said another nucleoside analog is
2 3TC.
- 1 3. The method according to claim 1, wherein said feline animal receives bone
2 marrow transplantation after total body irradiation.
- 1 4. The method according to claim 3, wherein the transplanted cells are selected
2 from the group consisting of allogeneic cells and autologous cells.
- 1 5. A method for treating or preventing infection of feline immunodeficiency virus
2 (FIV) in a feline animal, said method comprising administering to said feline animal an
3 effective amount of azidothymidine (AZT), another nucleoside analog and an inhibitor
4 of a retroviral protease.
- 1 6. The method according to claim 5, wherein said another nucleoside analog is
2 3TC.
- 1 7. The method according to claim 5, wherein said inhibitor of a retroviral
2 protease is selected from the group consisting of HIV protease inhibitors and FIV
3 protease inhibitors.
- 1 8. The method according to claim 5, wherein said inhibitor of a retroviral protease
2 is designated as HBY-793 and has the structure shown in Figure 4.

1 9. The method according to claim 5, wherein said another nucleoside analog is
2 3TC and said inhibitor of a retroviral protease is designated as HBY-793 and has the
3 structure shown in Figure 4.

1 10. The method according to claim 5, wherein said feline animal receives bone
2 marrow transplantation after total body irradiation.

1 11. The method according to claim 10, wherein the transplanted cells are selected
2 from the group consisting of allogeneic cells and autologous cells.

1 12. A kit comprising in one or more containers AZT, another nucleoside analog
2 and an inhibitor of a retroviral protease.

1 13. The kit according to claim 12, wherein said another nucleoside analog is
2 3TC.

1 14. The kit according to claim 12, wherein said inhibitor of a retroviral protease
2 is designated as HBY-793 and has the structure shown in Figure 4.

1 15. The kit according to claim 12, wherein said another nucleoside analog is 3TC
2 and said inhibitor of a retroviral protease is designated as HBY-793 and has the structure
3 shown in Figure 4.

1/7

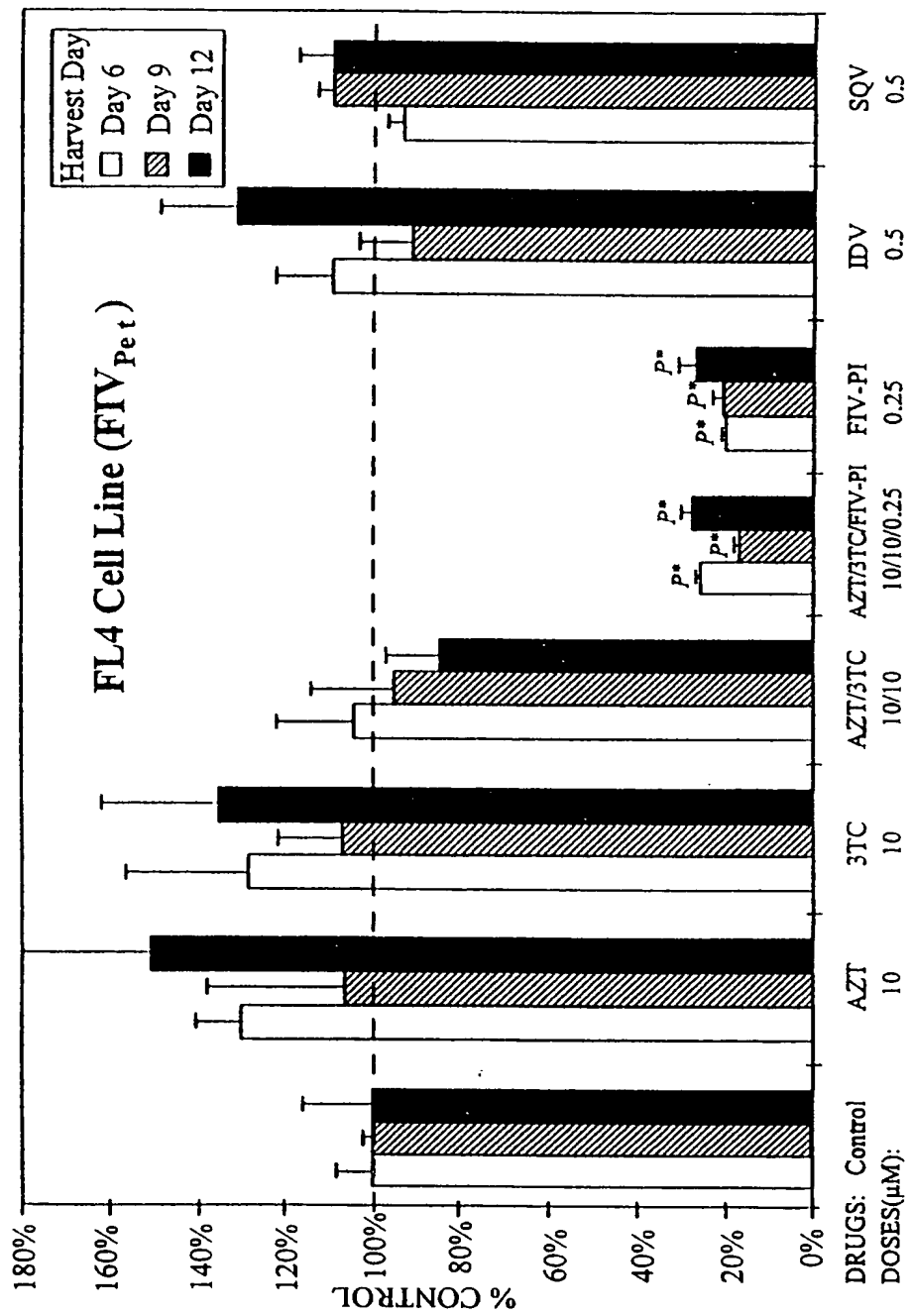


FIG. 1A

2/7

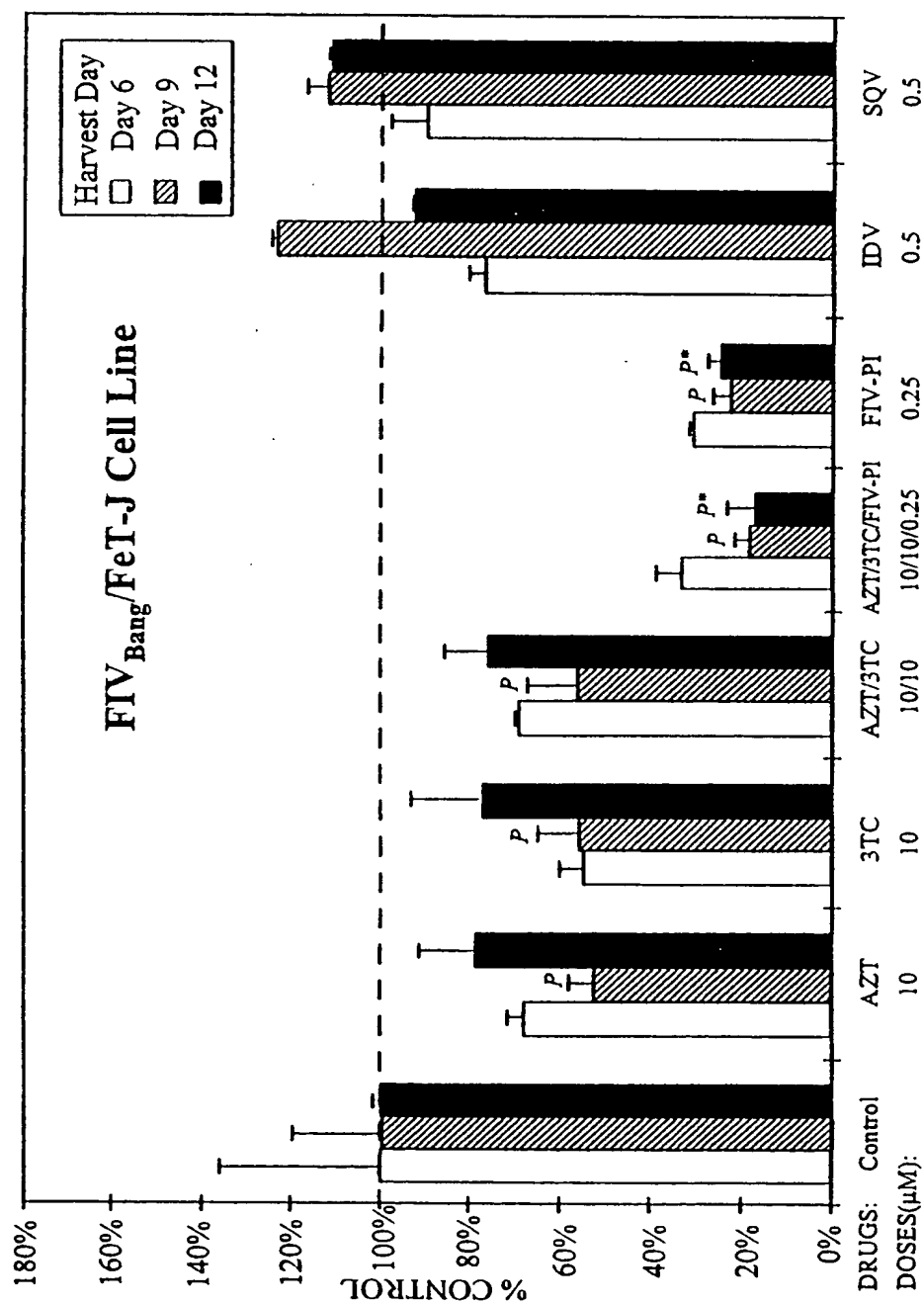


FIG. 1B

3/7

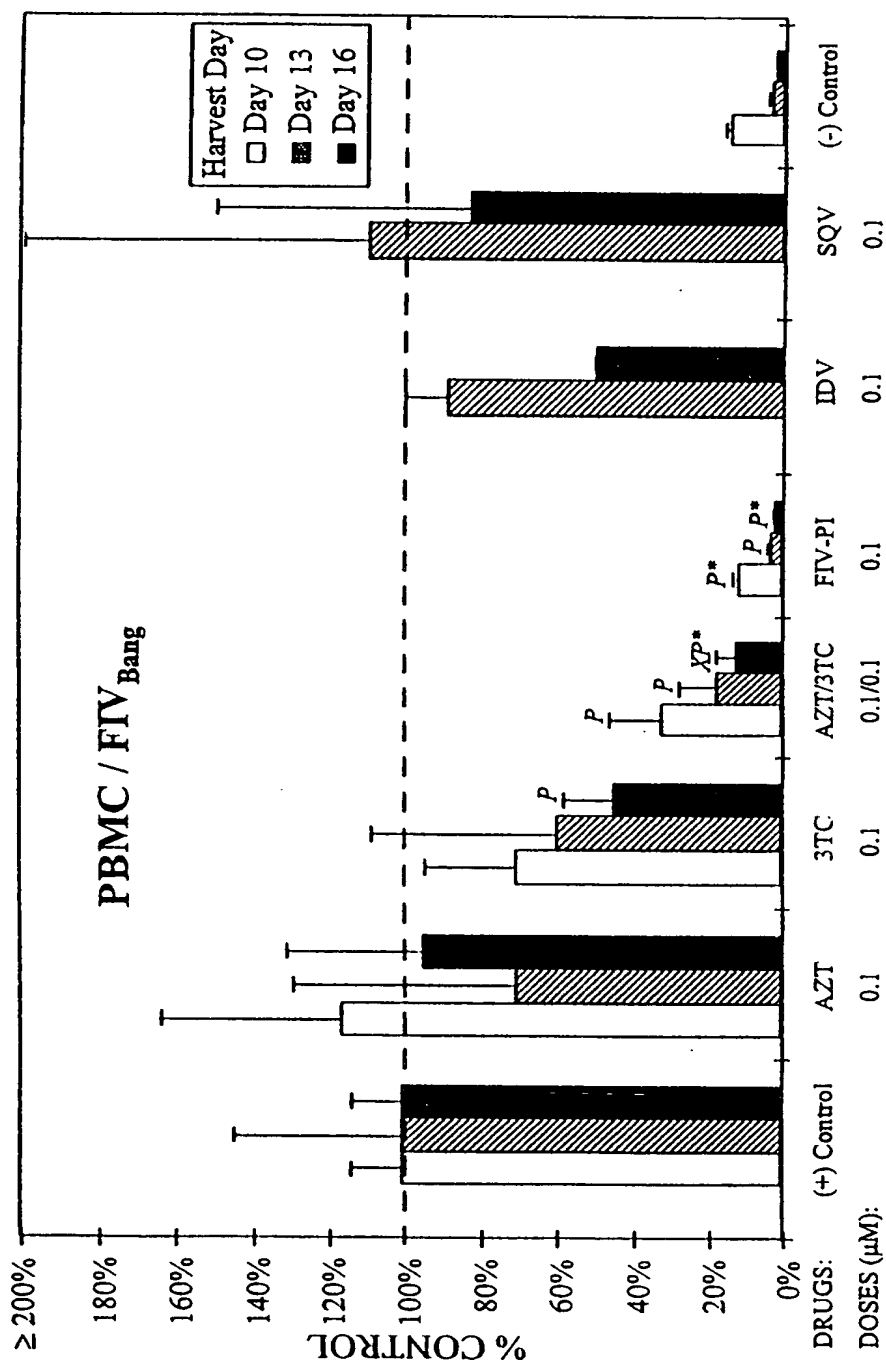


FIG. 2A

4/7

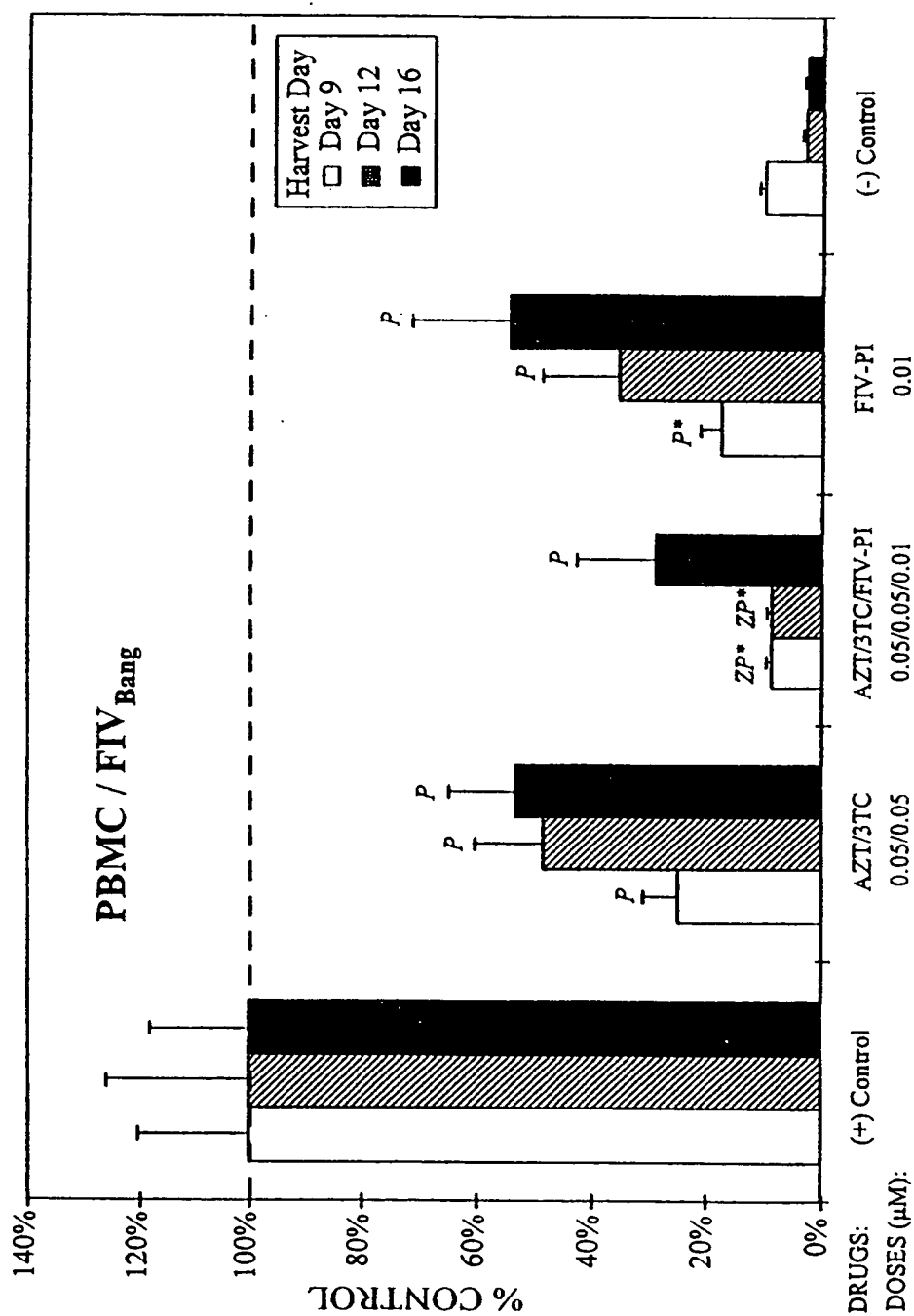


FIG. 2B

5/7

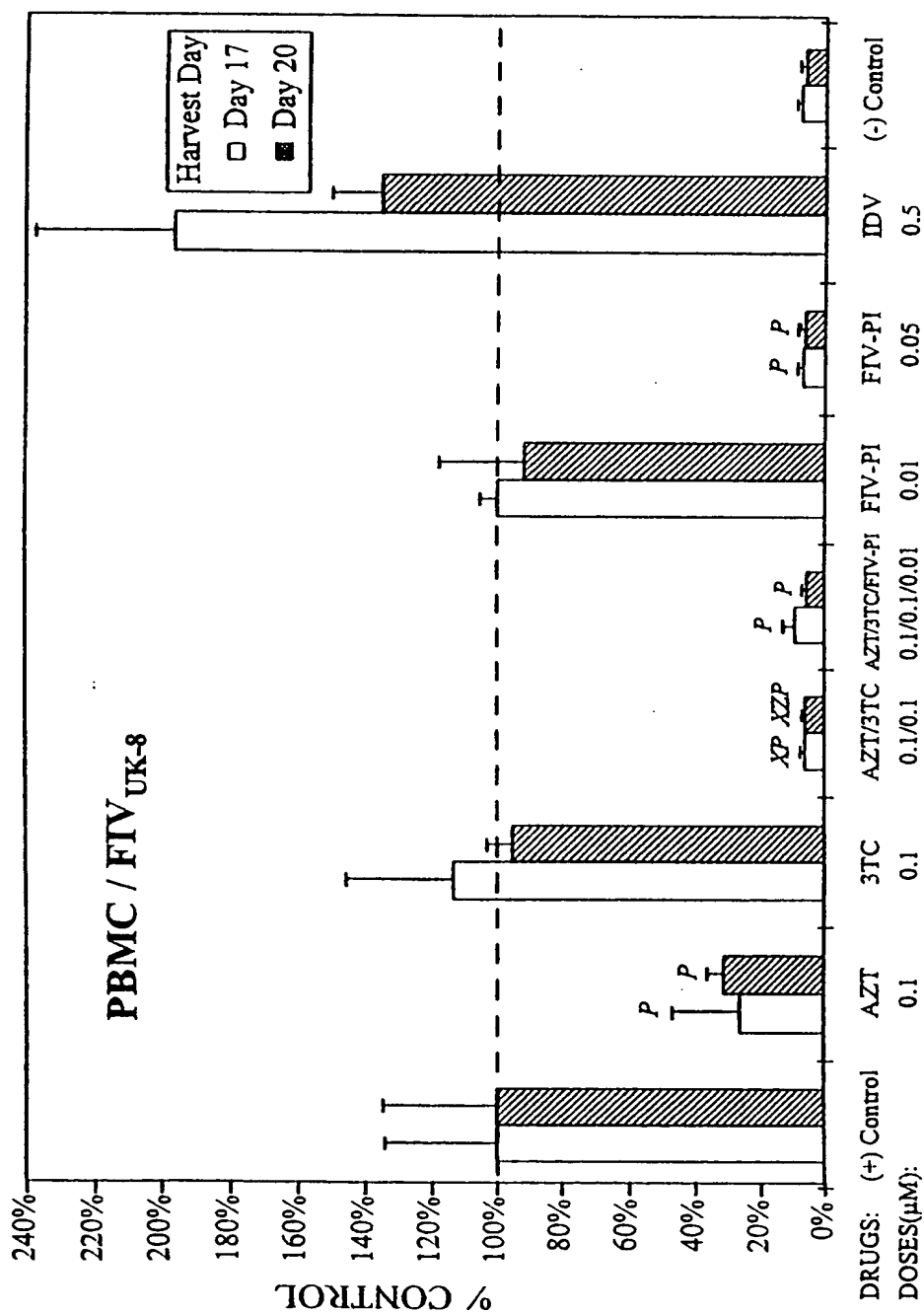


FIG. 3A

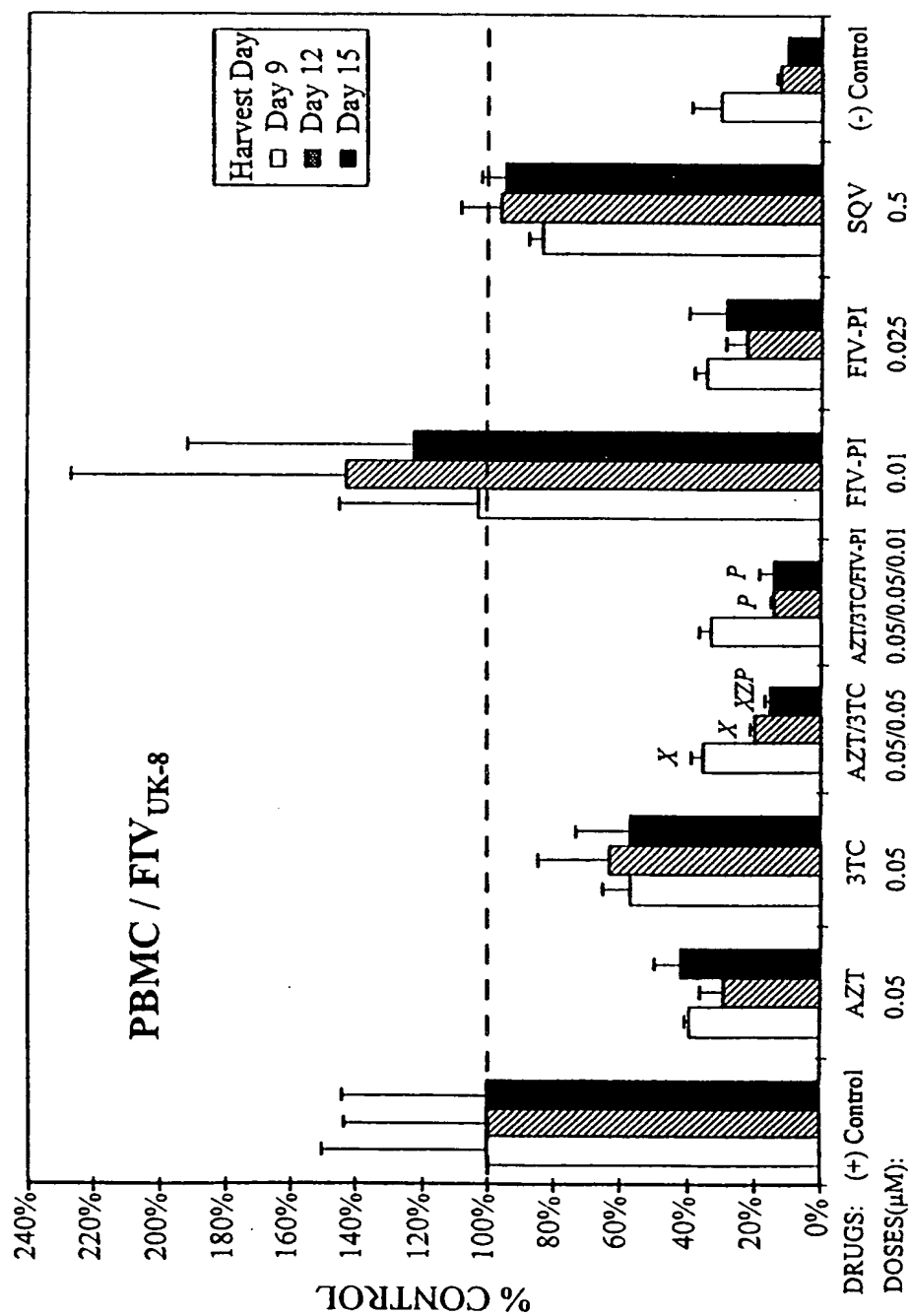


FIG. 3B

7/7

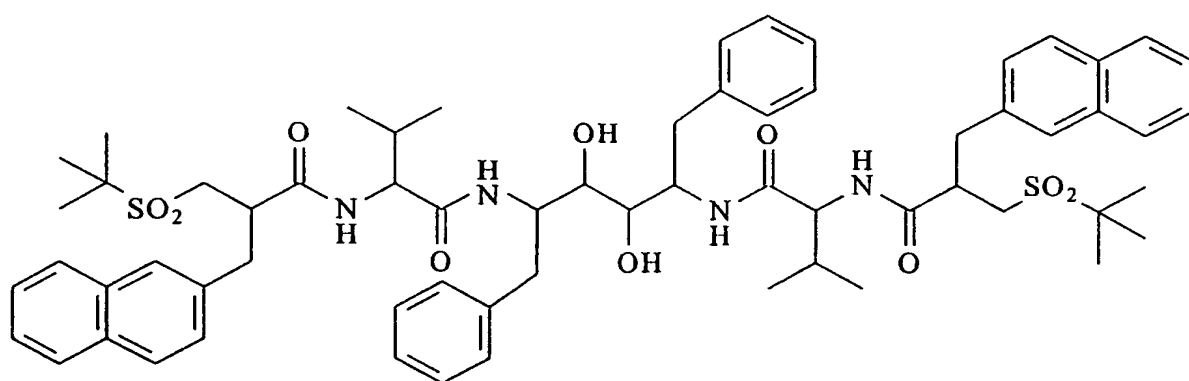


FIG. 4